Embedded Intel® Architecture: Powering the Internet Infrastructure

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Executive Summary

The Internet infrastructure is evolving to embrace the convergence of data, voice, fax, and video. As bandwidth increases, and 'Internet dial tone' becomes a pervasive commodity, differentiated services will become increasingly important sources of revenue for carriers and service providers. While 'Telcos' have traditionally delivered voice, and Internet Service Providers have delivered data, the convergence of voice and data and the proliferation of innovative value-added service offerings is spurring demand for a new generation of high-performance, scalable, upgradeable network infrastructure solutions based on standard platform building blocks. This transition is motivating equipment vendors who once developed their hardware and software solutions in-house to focus their available resources on the time-to-market development of differentiated software applications that enable value-added services.

Embedded Intel® Architecture (EIA) provides the hardware and software building blocks that enable third-party vendors of infrastructure solutions to meet the needs of Telcos and service providers. The performance and flexible open-architecture of Intel-based solutions is a cost-effective option for both equipment vendors and developers. For example, using Intel's scalable solutions, a developer can write a full-featured telephony application and then scale it down to a "lite" version for smaller service providers or corporate end-users. The inherent scalability and upgradability of embedded Intel Architecture solutions further enables OEMs to harness the continuous performance improvements to be derived from Intel's product roadmap. The flexibility of the architecture enables vendors to select the EIA building blocks that most cost-effectively meet today's most pressing development challenges, including time-to-market, time-in-market, price and performance. In these ways, embedded Intel Architecture is helping the communications industry build a new Internet infrastructure equipped to deliver rich new data types and a range of new services.

The Evolving Network Infrastructure

On its most basic level, as depicted in Figure 1, the network infrastructure includes core, control, and edge/access interface elements that provide the connection to customer premise equipment (CPE). The core, which includes transport, switching and routing equipment, forms the backbone of the transmission network, and is increasingly based on optical technologies. Edge equipment represents the points of network entry, exit, and aggregation. At an access point, individual subscriber traffic is concentrated into a smaller number of trunks for transport to the network core.

Control equipment is responsible for the integrity of transmission and network management functions, including fault detection and management, network configuration, equipment usage accounting, performance management, and network security.

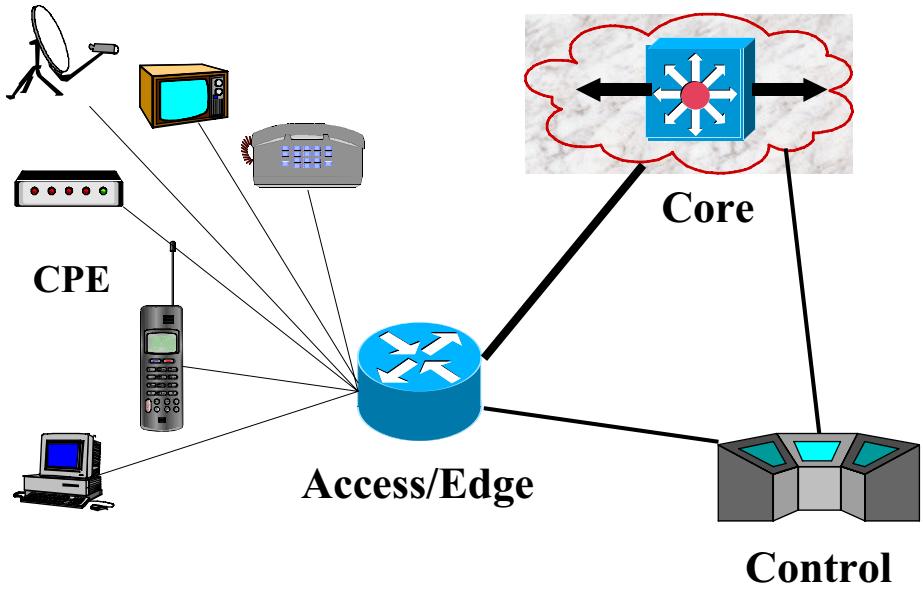

Figure 1 - Typical Network Infrastructure

Source: Frost & Sullivan

Service Provider Requirements

Today's network is comprised of a combination of legacy, circuit-switched systems, operated primarily by incumbent local exchange carriers (ILECs), and packet-based systems characteristically operated by integrated service providers and emerging specialized service providers. The evolution in infrastructure equipment is being largely driven by the competitive requirements of these service providers, who are working to satisfy a growing set of user demands. For example, in the late 1990s the explosion in consumer demand for data and access speed at the network edge began to drive the development of IP-enabled local loops based on DSL, cable modem, fiber-in-the-loop, and fixed wireless technologies. Going forward, service provider requirements for broadband communications will challenge equipment manufacturers to develop more powerful routers and cross-connects, gateways, long-reach dense wave division multiplexing, bandwidth managers, and cross-domain network managers. In addition, as network equipment evolves, OEMs will need to be even more capable of supplying infrastructure that supports differentiated services. By providing a scalable and flexible open architecture for the network infrastructure based on embedded Intel Architecture, OEMs can begin to meet these requirements.

The Need for Performance

The convergence of data and voice is creating a requirement for higher system-level performance to support more data, new applications, and new services. In the past, networks were designed primarily for packet throughput. With the emergence of more complex applications, the focus is shifting to the provision of value-added services. It also creates significant new opportunities for developers in the following areas:

- Unified Messaging, including voice, data, fax, and multimedia
- Voice over IP (VoIP), including IP-PBXs, 3G Wireless, and call centers
- Telephony and data services available from remote locations, including storage and interactive voice response
- Security, including virtual private networks and intrusion detection systems.

In general, the convergence of data and voice require a layered architectural approach that separates 'packet forwarding' functions from 'compute intensive' functions.

EIA and the Intel® Internet Exchange Architecture

The Intel® Internet Exchange architecture (IXA) provides a flexible framework for designing powerful and flexible networking and telecommunications solutions, and embedded Intel Architecture plays an important role. Intel IXA consists of top-to-bottom silicon and software building blocks, including embedded versions of the Intel® Pentium® III and Intel® Celeron™ processors, the Intel® IXP1200 network processor, and silicon dedicated to switching, formatting and packet forwarding. Because it is based on programmable silicon, Intel IXA allows systems designers to add functionality in software. Applications range from high-bandwidth Internet access switches to virtual private network add-on boards and appliances.

The relationship of embedded Intel Architecture and Intel IXA is illustrated in Figure 2.

The Applications and Services Layer at the top of Figure 2 is where embedded Intel Architecture applications processors run under general-purpose operating systems. Applications include: 3G wireless gateways, VoIP gateways, PBX/IP applications, and data center applications, including billing management systems.

The Control and Management Layer typically features a processor running under a real-time operating system. Applications include base station controllers, central office switches, and SS7 signaling. Enterprise level control at the Control and Management Layer can include high-end core/WAN switches and routers, high-speed access racks, and advanced intelligent networks.

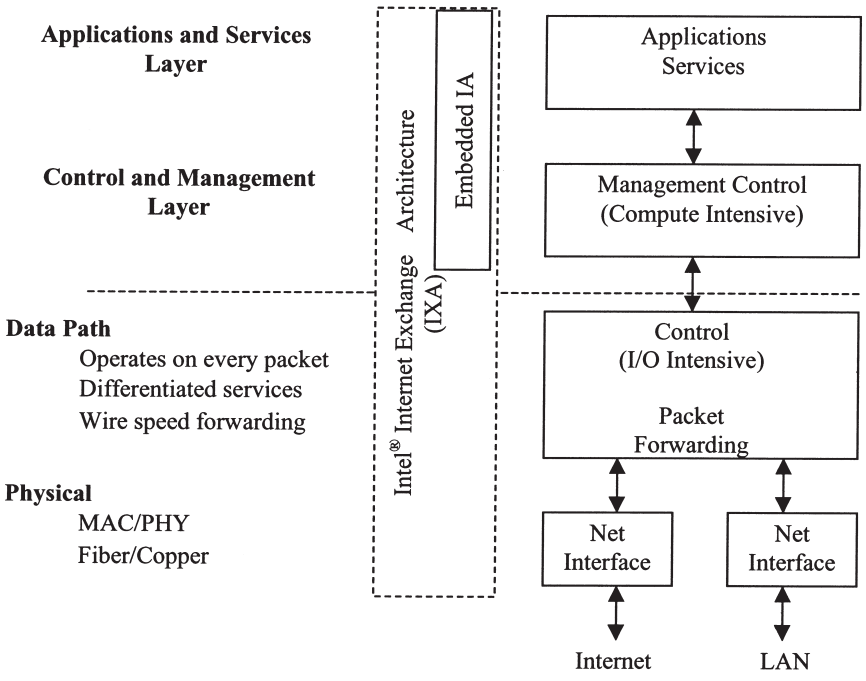

Figure 2 - Embedded Intel® Architecture and Intel® Internet Exchange Architecture

Embedded Intel Architecture and Intel IXA help to create a new infrastructure development ecosystem by providing proven technology with open hardware building blocks, complementary middleware, and third-party boards, systems, tools, and applications support.

EIA and Intel IXA – Delivering Performance with Scalability

For carrier-class devices that require increased applications processing power and throughput, such as the switch/router shown in Figure 3, the Pentium III processor provides ample performance headroom.

The Intel® 840 chipset has been validated for use with the Pentium III processor. It supports a high level of system-level performance, including support for single or dual-processor configurations, a 32/64-bit PCI bus, up to 4 Gbytes of RDRAM, and the throughput of a 100 MHz or 133 MHz front-side bus.

Additional bus and functional blocks are also featured. The Intel IXP1200 network processor handles OSI Layer 4 and 5 control functions. The Internet Exchange (IX) Bus is the packet bus used for packet routing and interfaces with the LAN and WAN.

A Comparison of EIA-based Designs

To illustrate the scalability of Intel IXA-based designs, Figure 4 features a comparison of entry-level and high-performance VoIP devices.

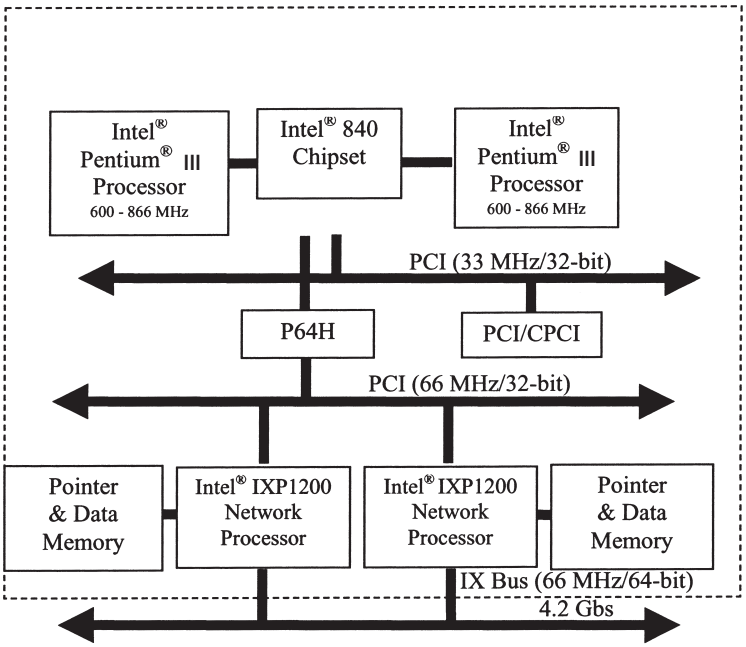

Figure 3 - Carrier-Class Switch/Router Block Diagram Based on Embedded Intel® Architecture and Intel® Internet Exchange Architecture

Software and Development Tools

In addition to hardware building blocks, embedded Intel Architecture supports software that includes a wide variety of general-purpose and real-time operating systems, system BIOS releases, and compilers. Another significant advantage of embedded Intel Architecture is its depth of development tools for performance analysis, software development, and hardware integration. Embedded Intel Architecture supports a high degree of code compatibility, which in turn helps minimize time-to-market. Once their system hardware has been deployed, vendors can add differentiating features through software modifications. This platform-based approach to development maximizes the "time-in-market" for a given hardware design, and enables developers to easily implement value-added features without expensive re-engineering.

EIA Provides a Rich Development Environment

Embedded Intel Architecture provides a rich development environment with open architecture, robust roadmaps, extensive scalability, life-cycle support, familiar development tools and wide third-party support for industry standards, including CompactPCI solutions, operating system/RTOS, and software. By integrating hardware and software building blocks through all levels of the network infrastructure, Intel can deliver strong time-to-market benefits with significant price and performance advantages. As a result, OEMs can in turn provide robust solutions for the communications infrastructure, characterized by high availability, the cost-effective deployment of differentiated services, and superior system management capabilities.

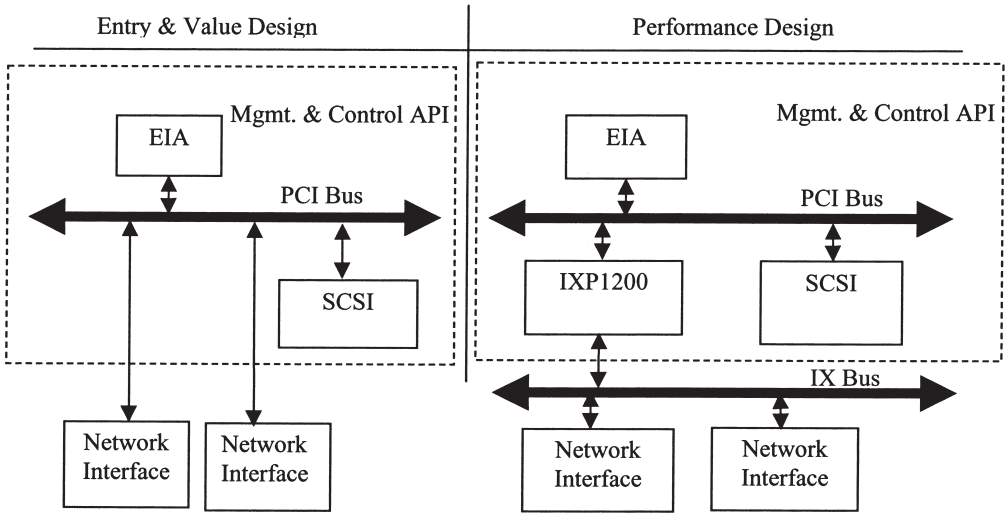

Figure 4 - Scalability Comparison of VoIP Designs Based on Embedded Intel® Architecture (EIA)

Conclusion

As affordable bandwidth becomes widely available, the network infrastructure will be required to handle expanded communications traffic. In addition to moving more data, network infrastructures are being challenged to support the transfer of more kinds of data, including voice traffic. At the same time, the commoditization of bandwidth can be expected to trigger a proliferation in service provisioning, including quality of service and billing services, which in turn will run on complex and processor-intensive applications. This new functionality requires the deployment of increased processing power and control capabilities throughout the network infrastructure.

Embedded Intel Architecture meets these requirements by providing a high-performance, scalable and easily upgradeable development platform that enables the time-to-market development of Internet infrastructure solutions. In addition to delivering high performance, EIA infrastructure solutions support a variety of operating systems, flexible board designs, and networking applications, supported by a broad spectrum of well understood development tools. As the needs of the network infrastructure continue to grow, the Intel roadmap enables developers to keep delivering the innovative solutions that today's competitive environment demands.

For More Information

For more information on embedded Intel Architecture Communications Reference Designs, including block diagrams and downloadable schematics, visit Intel's Developer Site:
developer.intel.com/platforms/applied/comm

For more information on Intel Internet Exchange Architecture solutions, visit Intel's IXA Web site:
www.intel.com/IXA

Figure 1 - Typical Network Infrastructure used with permission by Frost and Sullivan.

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